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A STUDY OF HOW METROPOLITAN SECONDARY MATHEMATICS TEACHERS ARE INTEGRATING MICROCOMPUTERS INTO THEIR CLASSROOMS

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Running head: Integration of Microcomputers

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National spending for microcomputers for instruction continues to grow with state departments of education reporting an estimated $550 million spent for computer hardware, and $130 million for software in 1985/86 (Bozeman & House, 1988). One reason so much money is spent on computers is the belief that "computer-based practice substantially raises achievement scores, primarily in mathematics" (Hativa, 1988, p. 367). The integration of the computer into the curriculum is thus seen as one way to increase student achievement.

Mathematics Curriculum and the Computer

Mathematics is one of the dominant subject areas in which the computer is used for classroom instruction. One research study (Suydam, 1985) has shown that the usefulness of the computer as a tool for mathematics instruction has been accepted, but the task of integrating the computer into the curriculum has just started.

Integration of the computer into the regular curriculum is defined as using the computer to introduce, reinforce, supplement, and/or extend skills. Integration is not teaching about the computer as a subject, rather it is the use of the microcomputer to deliver instruction. Most schools today have computers that are available for use by mathematics teachers as well as other teachers, but the question is, are they used by mathematics teachers? And, if they are used, how are they used by math teachers and students? The focus of this study is on determining how computer applications are integrated into mathematics instruction.

Implementation Goals

One of the main curriculum goals of the National Council of Teachers of Mathematics (NCTM) is that students should

expect to use computers in mathematics classrooms to enhance the learning of mathematics concepts and show applications of mathematical strategies (Lichtenberg, 1988). NCTM, however, has failed to provide any substantial justification or details on how to implement this curriculum goal. Similarly, in summarizing recommendations by leading researchers on the use of computers in school mathematics, Day (1987) found that most research provided very little detail or strategies for integration of computers into the curriculum. The *Conference Board of Mathematical Sciences* (1983) provided some detail on how the computer could be used in the curriculum. The Board examined the mathematics curriculum and made suggestions for the inclusion, exclusion, or emphasis of topics based on emerging computer technology (Day, 1987). The Board's recommendations are helpful for administrators but not specifically for teachers.

Educating Americans for the 21st Century (1983) specified three educational uses of the computer: learning <u>about</u> computers through computer literacy instruction and computer programming; learning <u>through</u> computers, by programs such as drill and practice, tutorials, and computer assisted instruction; learning <u>with</u> computers, by using the computer as a tool for instruction (Day, 1987). The authors presented details pertaining to the preparation of teachers to use technology and suggested several strategies state and national agencies could implement to educate teachers about computers.

Little, Hannum, and Stuck (1989) provided information on how teachers can effectively integrate computers into instruction by providing a framework to apply to any subject area. The basic instructional model is divided into "four main parts: (1) establishing instructional objectives, (2) determining entering behavior, (3) implementing instructional procedures, and (4) evaluating performance" (Little, et al., 1989, p. 11). This basic instructional model provides a simple conceptualization of the instructional process. The

use of this model provides a foundation for all instructional levels because it organizes "the concepts, principles, and procedures that are involved in the use of computers for instruction" (Little, et al., 1989, p. 11).

Barriers to Utilization

A review of recent literature revealed strong recommendations and expectations for the mathematics teacher to integrate the microcomputer into the mathematics curriculum, but there was little evidence to suggest that teachers are actually using the computer in the classroom. The problem then, is not one of providing access to the technology, but rather one of integrating the technology into the curriculum.

One reason these changes are not taking place is that there are few guidelines to aid mathematics teachers in using computers in their classrooms and few state mandates that require computer use. A second reason computers are not integrated into the mathematics curriculum is that some teachers do not have the skills or knowledge they need to feel comfortable with the computer as a regular tool for classroom instruction (Day, 1987). A third reason that computers are not integrated into the mathematics curriculum is the failure of educators to maintain and update the computer hardware and software.

Existing Classroom Practice

Many authors believe the computer provides a way to teach existing topics better and more effectively (Day, 1987). In 1985, the Center for Social Organizations of Schools, located at Johns Hopkins University, conducted an extensive survey of teachers and principals on the topic of instructional uses of computers (Becker, 1986). The results of the survey revealed four main areas where computers had a significant impact on education. They were: "(1) increased student motivation, (2) increased student cooperation and

independence, (3) increased learning opportunities for high-ability students, and (4) increased opportunities for low-ability students to master basic skills" (Little, et al., 1989, p. 5).

Research indicates (Bracey, 1988; Hativa, 1988; National Council of Teachers of Mathematics, 1985; Winkler, Shavelson, Stasz, & Feibel, 1985) that most of the teachers with access to computers do not use them, but on rare occasions and when they do, the computers are utilized for demonstration, motivation, or computer literacy.

Research related to the impact of computers on student achievement and use has not provided consistent and clear findings for how to integrate computers into the curriculum. Hativa (1988) summarized the results of numerous studies that examined the effectiveness of computer-based drill and practice. The results for drill and practice were mixed suggesting that other factors besides the software may be responsible for achievement. Thus, while many computer programs are designed to increase achievement, whether the achievement increases or not may depend on the learning style of the student and how the teacher plans and implements the instruction.

The Instructional Environment

The location of the computers is important. The availability of the computers shape whole class demonstrations, small group activities, and individual activities incorporating the computer into teaching strategies (Bullock, 1988). Computers in the classroom allow the teacher to have whole class demonstrations without detracting too much from the lesson. Teachers can send individual students to work on the computer for enrichment or remedial purposes while working with the remaining class members on other material.

If computers are not available in the classroom, students must go to a computer lab to use computers which

might require scheduling of the lab. The teacher then has to compete with other curriculum areas to use the computer lab and determine alternatives if the lab is not available.

The student to computer ratio is an important aspect of the computer environment. Bullock (1988) concluded that there should be no more than two secondary students per computer because each student needs to practice the objective being tested. Bullock (1988) also found that cooperative groups can be helpful to the student by promoting motivation and competition.

Present Study

Subjects

The subjects in this study consisted of secondary mathematics teachers in an urban school district. The sample consisted of 200 secondary math teachers from 54 different schools across the district. They were selected randomly from the list of 325 available teachers. These teachers were full-time or part-time and were diversified with regard to age, gender, experience, education, school, and ethnic group.

Design

The design of this study was descriptive in nature. It consisted of collecting survey data on (a) background of teachers, (b) how teachers used computers in the mathematics classroom and the frequency of use, (c) the environments in which computers were used, (d) attitudes of mathematics teachers toward using computers for instruction as well as toward the available mathematics software, and (e) what teachers felt were the advantages and disadvantages of using computers in mathematics classrooms.

Instrumentation and Data Collection

A questionnaire was used to determine how teachers integrate the computer into the mathematics curriculum. The

questions were mainly closed in form with four open-ended questions. The questionaire was pilot-tested on a group of four secondary math teachers and the Supervisor of Computers for the district before it was distributed.

The first section of the questionnaire consisted of general background information questions about the teachers. The second section of the questionnaire concentrated on how teachers were using computers in the mathematics classrooms. These questions were all checklist questions to identify classes in which teachers were using computers, types of software programs they currently used, and how often they used computers.

The third section of the questionnaire had yes/no and checklist types of questions concerning where the computers were located within the school, the number of computers available, availability of the computers, scheduling requirements, number of students on one computer and student access outside of class. The fourth section of the questionnaire was designed to collect data concerned with teachers' attitudes toward computer utilization, mathematics software, and instructional purposes of computers.

The fifth section of the questionnaire contained five open-ended questions to allow the teachers to express their feelings about computers in the mathematics classroom. The questions addressed what teachers saw as the main advantages and disadvantages of computers in the mathematics classroom

Questionnaire Administration

The questionnaire was distributed through the U.S. mail. Teachers who did not respond after two weeks were sent a follow up letter and the same questionnaire. Approximately 128 questionnaires were returned by the second mailing. Sixty-four percent of the sample population responded to the survey.

Analysis

The survey data were analyzed using descriptive statistics, consisting of item percentages, frequencies, and means. A post-hoc analysis was done using t-tests to determine any significant differences between the way selected groups of teachers answered the attitude section questions. There were also chi-square tests done to determine if any significant difference existed between computer-using and nonusing teachers and selected demographic items.

DISCUSSION

A sample of 200 was randomly selected from the population of 325 secondary mathematics teachers to respond to a questionnaire about how microcomputers are being integrated into the mathematics curriculum. A total of 128 teachers (64%) responded to the survey.

Several of the conclusions drawn from prior research were supported by the current study. Approximately 90% of the teachers felt that computers were very useful in helping convey mathematics concepts, however about half of the teachers from this study had not used computers to help convey mathematics concepts. Teachers seem to have accepted the usefulness of the computer as a tool for math instruction, but the task of integrating them into the curriculum has just started. This study found that teachers who used computers were integrating the computer into mathematics instruction for drill and practice, enrichment, and remediation. Only 25% of the teachers, however, used computers once a week or more.

Research showed that groups, such as NCTM, are emphasizing the integration of computers into the math curriculum, but there are few guidelines to aid math teachers

in using computers in their classrooms and only a few states mandate computer use for instruction. Both users and nonusers (35%) in this study felt that the district did not provide guidelines which identified software to use with specific math curriculum topics. The state requires Seventh and Eighth graders to study a unit on computer literacy. Although the computer literacy unit may be taught by math teachers, the curricula is not directly related, if at all, to mathematics.

Many researchers have agreed that the computer provides a way to teach existing topics better and more effectively. Teachers in this study also agreed with this conclusion. Seventy-five percent of the users and nonusers felt that the use of computers in math classes can accelerate students' mastery of the subject matter and that giving students access to computers through their math classes increases their motivation to learn math.

Research Question 1: How are microcomputers being integrated into mathematics curriculum by teachers?

The findings revealed that approximately one-half of the teachers surveyed had used computers to teach mathematics. The majority of the teachers who used computers taught courses that were typically junior high math classes. Only a small percentage of computer-using teachers used computers to teach upper level math courses. The results indicated that the most frequently used type of software was drill and practice, followed by games and tutorial software.

In the open-ended items, teachers revealed that the main advantage of using computers was that the novelty of the technology seems to motivate their students. They also felt that computers provide excellent drill and practice and review of previous skills.

The main disadvantage that teachers revealed was the lack of hardware and good software which was correlated to

curriculum objectives. Another disadvantage teachers cited was the lack of class time to cover the present curriculum, which left little time to plan for and use computers in the classroom. The responses suggested that teachers need more detailed guidelines which prescribe the software to be used to assist in teaching specific components of the curriculum.

Research Question 2: What environments are most conducive to the integration of computers in mathematics classrooms?

The main reason that nonusers did not use computers more was that the computers were inaccessible during all classes or for extended use. Approximately 40% of the teachers said that they did not have access to a lab for each class. A higher percentage of teachers used computers once a month or more when they had access to the lab for all classes. Obviously, in order for teachers to be able to integrate computers into the mathematics curriculum, the computers must be available for the teachers to use when they need them. Almost 60% of the teachers did not have a computer in their classrooms. Of the 40% that did have computers in their classrooms, most used computers once a week or more. These results suggest that having a computer in the classroom promotes the instructional use of computers.

A major problem cited with using computers is the student computer ratio. Teachers explained that they would use computers more if they could have a lower computer to student ratio.

Research Question 3: What are the attitudes of mathematics teachers toward computer utilization, mathematics software, and instructional purposes of computers?

The majority of the teachers expressed a positive attitude toward computer use in mathematics and felt that educators must increase the exposure of students to learning with computers. Money spent on software, computers, and training teachers in the use of computers was perceived as

money well spent. There were three items that were rated lowest concerning computer utilization. First, teachers felt that it was not easy to schedule time in the lab. Second, if teachers use computers then they did not feel that the computers tended to reduce paperwork. Third, teachers felt that principals are not encouraging the use of computers in their classes.

Teacher attitudes toward mathematics software were the least positive of the three subscales. Most teachers felt that they would like to incorporate computers more into their classrooms to help them teach math.

Recommendations

** Mathematics software must be matched to the curriculum objectives, and more attention should be given to correlating objectives to software.

** Math teachers need to become acquainted with the math software that is available.

** Computer laboratories need to become more accessible for math teachers.

** Computer laboratories also need to be more accessible to students.

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Table 1

Percent of Responses of Users, Nonusers, and the Total Group to Selected Demographic Items

Items		Percent of Responses Users (N=59)	Nonusers (N=64)	Total (N=123)
2. Age	a. 20-29	5	11	8
	b. 30-39	42	31	37
	c. 40-49	38	39	38
	d. 50-59	9	19	14
	e. 60 or older	5	0	2
3. Sex	a. male	29	38	33
	b. female	71	63	67
4. Race	a. Caucasian	56	56	56
	b. black	41	41	41
	c. other	3	3	3
5. Highest degree	a. Bachelors	42	48	46
	b. Masters	27	33	30
	c. Masters + 30	29	19	24
	d. Doctorate	2	0	1
6. Number of years teaching math	a. 1 to 5	15	35	25
	b. 6 to 10	28	24	26
	c. 11 to 15	17	8	13
	d. 16 to 20	26	16	21
	e. 21 or more	12	16	14
	f. no response	2	3	2
7. Grade levels of math classes*	a. Grade 7	34	30	32
	b. Grade 8	44	31	37
	c. Grade 9	42	38	40
	d. Grade 10	46	61	54
	e. Grade 11	46	59	53
	f. Grade 12	42	56	50
8. Math courses currently taught*	a. Gr 7 Arith	31	20	25
	b. Gr 8 Arith	34	17	25
	c. Gr 9 Arith	12	11	11
	d. Pre-Algebra	32	28	30
	e. Algebra I	29	30	30
	f. Geometry	19	20	20
	g. Algebra II	19	19	19
	h. Trigonometry	8	17	13

*More than one response was acceptable

Table 1 (continued)

Percent of Responses of Users, Nonusers, and the Total Group to Selected Demographic Items

Items		Percent of Responses Users (N=59)	Nonusers (N=64)	Total (N=123)
8. Math courses currently taught*(cont.)	i. Adv Math	10	17	14
	j. Calculus	7	6	7
	k. Applied Math	3	13	8
	l. other	3	2	2
9. Use computers	a. yes	100	0	48
	b. no	0	100	52
10. Years experience using computers in classroom	a. none	3	88	47
	b. 1-2 years	34	7	20
	c. 3-4 years	29	0	14
	d. 5 years or more	32	0	15
	e. no response	2	6	4
11. Source of primary training*	a. college	61	27	43
	b. in-service	49	30	39
	c. learned on own	47	14	30
	d. other	10	13	11
	e. no response	0	39	20
12. Used computer for keeping track of grades	a. yes	51	23	37
	b. no	47	73	61
	c. no response	2	3	2
13. Time since training	a. 1 year or less	52	65	57
	b. 2 years ago	22	10	17
	c. 3-4 years ago	21	20	20
	d. 5 years or more	5	5	5
14. Experience in programming computers	a. yes	63	42	52
	b. no	36	48	42
	c. no response	2	9	6
15. Written new computer programs	a. yes	39	19	28
	b. no	59	72	66
	c. no response	2	9	6
16. Used programs from magazines or books	a. yes	68	25	46
	b. no	32	66	50
	c. no response	7	9	5

*More than one response was acceptable

Table 2

Percent of Responses To Use of Computers in Mathematics Classrooms

Items		Percent of Users Responding N=59
17. Math courses currently using computers to teach math*	a. Gr 7 Arithmetic	32
	b. Gr 8 Arithmetic	36
	c. Gr 9 Arithmetic	13
	d. Pre-Algebra	26
	e. Algebra I	23
	f. Geometry	15
	g. Algebra II	13
	h. Trigonometry	8
	i. Advanced Math	6
	j. Calculus	8
	k. Applied Math	0
	l. other	2
18. Types of software programs used*	a. problem solving	49
	b. tutorial	56
	c. programming	11
	d. drill and practice	76
	e. games	58
	f. simulations	24
	g. other	11
19. Ways currently using computers*	a. to introduce new topics	30
	b. remediation	64
	c. enrichment	70
	d. to extend skills	55
	e. practice	74
	f. programming	8
	g. word processing	8
	h. data base management	4
	i. spreadsheets	4
	j. graphics programs	25
	k. to replace seat work	9
	l. other	2
20. Frequency of use of computers in math classes	a. once a week or more	25
	b. once every two weeks	22
	c. once a month	19
	d. rarely	35

*More than one response was acceptable

Table 3

Percent of Responses To Computer Environment

Items		Percent of Responses N=59
21. Number of computers in classroom	a. 0	58
	b. 1	28
	c. 2	3
	d. 4	2
	e. 16	3
	f. 22	2
	g. 23	2
	h. 24	2
22. Does your school have a computer lab available for all teachers?	a. yes	72
	b. no	28
22a. Number of computers in lab	a. 12	2
	b. 14	2
	c. 15	12
	d. 16	10
	e. 17	7
	f. 18	3
	g. 20	10
	h. 21	2
	i. 23	2
	j. 24	3
	k. 27	2
	l. 30	10
	m. no response	34
23. Do you have access to a lab for each class?	a. yes	54
	b. no	39
24. How often can your class use the computer lab?	a. 5 days a week	17
	b. 3 to 4 days a week	3
	c. 1 to 2 days a week	37
	d. other	31
	e. no response	10
25. How long can your class use the computer lab?	a. the whole class period	88
	b. half a class period	0
	c. less than half a class period	0
	d. other	0
	e. no response	12

Table 3 (continued)

Percent of Responses To Computer Environment

Items		Percent of Responses N=59
26. How far in advance do you have to schedule the lab for your classes?	a. 1 or 2 days in advance	29
	b. 1 week in advance	17
	c. 1 month in advance	5
	d. 6 weeks in advance	2
	e. a semester in advance	7
	f. a year in advance	5
	g. other	24
	h. no response	12
27. Do you make the same assignment to whole class?	a. yes	66
	b. no	19
	c. no response	15
28. Number of students working on one computer	a. 1	14
	b. 2	73
	c. 3	7
	d. 4	2
	e. 5	0
	f. 6 or more	4
29. Do students have access to lab outside of class?	a. yes	46
	b. no	51
	c. no response	3

Table 4

Summary of Respondents' Perceptions of the Advantages of Using Microcomputers

Question 60 - In my opinion, the three main advantages of using microcomputers for teaching mathematics are

	Responses	Frequency of Occurrence
a.	motivates students, students love it, enjoyable	40
b.	drill and practice, reviews skills	28
c.	individualized instruction, practice molded to fit students needs	18
d.	immediate feedback, trial and error	16
e.	tutoring software	12
f.	extends, improves, reinforces skills	11
g.	varies teaching methods	11
h.	makes learning situation concrete and real tool of present and future, and students can relate to today's world	10
i.	remediation software, helps with reteaching and lower skill students	10
j.	enrichment	7
k.	students can work at own pace, time saving	7
l.	speed of demonstration, quick, accurate	7
m.	visual aid	7
n.	reinforces textbook concepts	6
o.	student involvement greater	6
p.	graphics help student understand lesson	5
q.	reduces paper work, provides assistance	5

Table 4 (continued)

Summary of Respondents' Perceptions of the Advantages of Using Microcomputers

Question 60 - In my opinion, the three main advantages of using microcomputers for teaching mathematics are

Responses	Frequency of Occurrence
r. encourages student interest in math	4
s. increases comprehension, retention achievement	4
t. cooperative learning	3
u. familiarizes students with computer use, good "hands on" experience	3
v. introduces new topics	3
w. problem solving	3
x. availability	2
y. avoids repetition by teacher	2
z. chance for discovery	2
aa. evaluates data from experiment	2
bb. encourages thinking	2
cc. newness	2
dd. repetition	2
ee. simulations	2

Table 5

Summary of Respondents' Perceptions of the Disadvantages of Using Microcomputers

Question 61 - In my opinion, the three main disadvantages of using microcomputers for teaching mathematics are

	Responses	Frequency of Occurrence
a.	not enough computers, lack of hardware	26
b.	lack of appropriate, good software	25
c.	too much to teach already, lack of class time	13
d.	lack of time to select, preview, and set up to use	10
e.	too expensive	9
f.	students become too dependent on computers to do calculations, weakens their computational skills	8
g.	problems scheduling lab time	8
h.	maintaining equipment, often it needs to be repaired	7
i.	equipment is not accessible	6
j.	students don't know how to use computers, takes too much class time to teach them to use computers	6
k.	no computers in my class	5
l.	causes too much disruption	4
m.	teachers may use it as a baby sitter	4
n.	difficult to integrate (correlate) curriculum and software	4
o.	too difficult to grade computer work	3
p.	lack of space	3

Table 5 (continued)

Summary of Respondents' Perceptions of the Disadvantages of Using Microcomputers

Question 61 - In my opinion, the three main disadvantages of using microcomputers for teaching mathematics are

	Responses	Frequency of Occurrence
q.	lack of overhead viewer for class	3
r.	teachers not trained to use computers	3
s.	students think it is game time	3
t.	have to move to lab	2
u.	not enough disks	2
v.	differences in level of competency of students	2
w.	hard to use with large groups	2
x.	doesn't teach concepts as well as teacher does	2

Table 6

Summary of Respondents' Perceptions of The Reasons They Would Use Microcomputers More

Question 62 - I would use microcomputers more to help me teach mathematics if

Responses	Frequency of Occurrence
a. there was better access to the computers.	28
b. there were one or more computers available in the classroom.	26
c. better software that met curriculum objectives.	10
d. curriculum guides allowed time to use computers.	9
e. teachers were better trained on using the computer as an instructional tool.	7
f. my classes were smaller.	5
g. students were already familiar with how to use computers.	4
h. there was one computer for each student.	4
i. I had ample time to study and acquire appropriate programs.	3
j. there were more computers.	3
k. money was available for software.	2

Table 7

Summary of Respondents' Perceptions of the Reason They Do Not Use Microcomputers

Question 63 - The main reason I do not use microcomputers to help me teach math is

	Responses	Frequency of Occurrence
a.	inaccessibility of equipment during all classes or for extended use	25
b.	not enough computers	14
c.	teachers do not have enough training	8
d.	takes too long to find and learn the software	6
e.	do not have a computer in classroom	5
f.	lack of good software	5
g.	curriculum does not allow enough time	5
h.	location of lab	3
i.	classes are too large	2
j.	disruptive students cannot be separated	2